Weather or Not?

VOLUME 5, ISSUE 1 SEPTEMBER 2011

INSIDE THIS ISSUE

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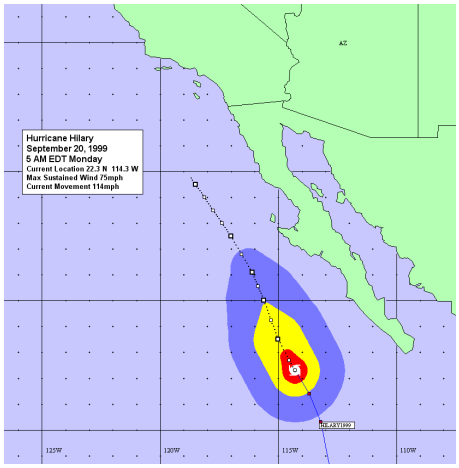
Would You Be Prepared For a Tropical Cyclone in Southern California?

By Eric Boldt

The odds of a tropical storm or a minimal-strength hurricane hitting the southern California coastline are very low, but the reality is that it's definitely possible. Four tropical cyclones have managed to bring tropical storm–force winds to the southwestern United States during the twentieth century: a tropical storm on 25 September 1939 in California, Hurricane Joanne on 6 October 1972 in Arizona, Hurricane Kathleen on 10 September 1976 in California and Arizona, and Hurricane Nora in September 1997 in Arizona. Only the 1939 tropical storm made a direct landfall in coastal California near the San Pedro Peninsula. **(Please see Page 4 for a complete list of tropical cyclones that affected Southern California in the 20th Century.)**



Hurricane Hillary off the coast of Baja – Sept. 20, 1999
(Blue color is tropical storm-force winds, Red is hurricane-force winds)

The 1939 no-named tropical storm caught many boats by surprise as they headed back to the mainland from Santa Catalina Island, following a prolonged heat wave across southern California. Unfortunately, approximately 45 people lost their lives when their boats capsized before reaching shore and there were over $2 million (over $31 million today) in property damages to the shipping industry, coastal structures, and crops. Following this disaster, the Los Angeles National Weather Forecast Office was established (in 1940) to make daily weather forecasts and provide watches and warnings for the southern California region. National Hurricane Center scientists established that the 1939 tropical storm was the 38th most deadly tropical cyclone to hit the U.S. since 1851. Ironically, at least 90 people reportedly lost their lives due to a record-breaking heat wave that engulfed the southern California area with daily temperatures over 100 degrees during the week leading up to the land-falling tropical storm.

Many scientists have concerns that a Category 1 (sustained winds at least 74 mph) hurricane along the Los Angeles coast would be much more devastating than a tsunami, given the historical record of both types of events in this part of the country. On October 2, 1858, a minimal strength hurricane skirted the San Diego coastline before moving northwest and weakening over the Channel Islands. This is the closest that a hurricane has come to making landfall along the California coast since record-keeping began in the nineteenth century.

Hurricanes need very warm ocean temperatures to survive a trip northward from their origination area off the southwest coast of Mexico. Sea surface temperatures of at least 80 degrees Fahrenheit (27 degrees Celsius) are essential to power the heat engine of a hurricane. El Niño years can bring warmer ocean temperatures to the south coast of California, especially during

(Continued on Page 2)

Office Comings and Goings

By Joe Sirard

We welcome meteorologist Carol Smith who's last duty station was Eureka, CA. She began working at NWS Oxnard in early August as a General Forecaster.

Bill Hoffer, long-time Hydrometeorological Technician at NWS Oxnard will be retiring near the end of October after 32 years of Federal Service. Many of you I am sure are familiar with his distinctive voice and friendly demeanor. He will be missed by all!

Would You Be Prepared For a Tropical Cyclone in Southern California?

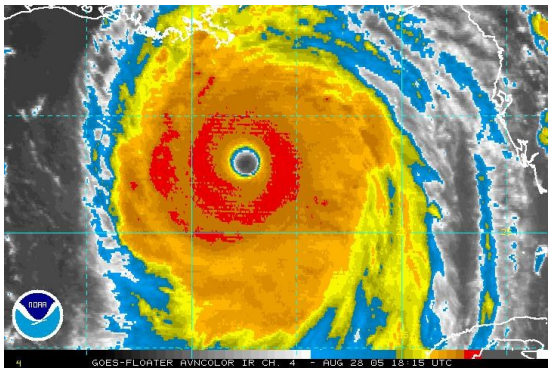
(Continued from page 1)

the months of September and October. Wind shear, or the shift in wind direction and/or speed with height is a major contributor to the weakening of hurricanes as they move into more northern latitudes. Wind shear, cooler ocean temperatures or a combination of the two greatly influence the weakening of tropical cyclones into tropical depressions (sustained winds less than 39 mph) or dissipating tropical cyclones well before entering the coastal waters of southern California.

The main weather hazards associated with tropical cyclones are the following:

High Winds

Winds associated with tropical cyclones are measured on the Saffir/Simpson hurricane scale in categories from 1 to 5 as sustained wind speed values. Property damage is likely to occur at the lowest category and extensive damage at category 4 or higher.



Cat. 5 Hurricane Katrina over the Gulf of Mexico – Aug. 28, 2005

Tropical storm force winds = 39-73 mph

Saffir/Simpson hurricane scale

Category 1	-	74-95 mph
Category 2	-	96-110 mph
Category 3	-	111-130 mph
Category 4	-	131-155 mph
Category 5	-	> 155 mph

Storm surge

Storm surge is simply water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. In addition, wind driven waves are superimposed on the storm surge. This rise in water level can cause severe flooding in coastal areas, particularly when the storm surge coincides with the normal high tides.

Galveston, TX following Hurricane Ike [dvorak.org]

Inland Flooding

Extreme rain events in the southwestern United States are the most frequent effect of tropical cyclones in the region. High winds, coastal storm surge and wave action are much less frequent. Rainfall intensity will also increase at higher elevations where recent burn areas are susceptible to flash flooding and debris flows. The 1939 tropical storm in southern California resulted in 5.66 inches of accumulated rainfall in downtown Los Angeles (5.24 inches in 24 hours) and 11.60 inches recorded at Mount Wilson, both continue to be records for the month of September.

Tornadoes

Tornadoes are most likely to occur in the right-front quadrant of a tropical storm or hurricane. Some tropical cyclones seem to produce no tornadoes, while others develop multiple ones. Studies have shown that more than half of the landfalling hurricanes produce at least one tornado.

For more information about tropical cyclones, please visit the following internet pages:

National Hurricane Center - www.nhc.noaa.gov

NWS Oxnard hurricane page - http://www.wrh.noaa.gov/lox/main.php?suite=safety&page=tropical

All About CoCoRaHS

What is CoCoRaHS?

The **C**ommunity **C**ollaborative **R**ain, **H**ail and **S**now Network, is a non-profit, community based, high density network of volunteers who take daily measurements of rain, hail and snow in their backyards.

A Brief History

CoCoRaHS came about as a result of a devastating flash flood that hit Fort Collins, Colorado in July 1997. A very localized storm dumped over a foot of rain in several hours while other portions of the city had only modest rainfall. The ensuing flood caught many by surprise and caused $200 million in damages. CoCoRaHS was born in 1998 with the intent of doing a better job of mapping and reporting intense storms. As more volunteers participated, rain, hail, and snow maps were produced for every storm showing fascinating local patterns that were of great interest to scientists and the public. By 2010 CoCoRaHS became a nationwide volunteer network.

Volunteers of all ages welcome!

The foundation of the CoCoRaHS network are individuals and family volunteers of all ages, from all walks of life, willing to spend a few minutes each day measuring and reporting precipitation. This is a project we can all help with.

Training: "the Key to our success"

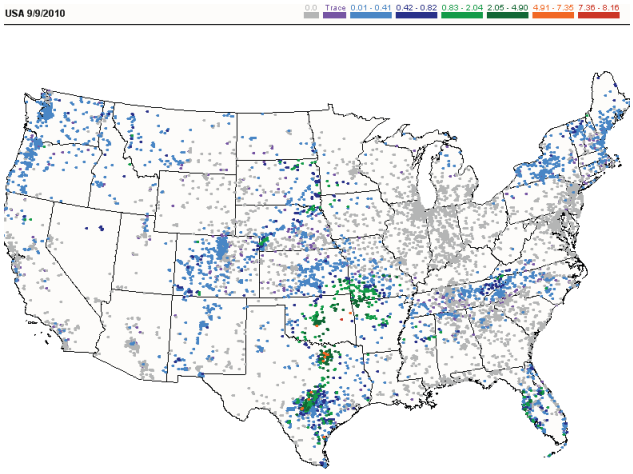
It is important that all CoCoRaHS precipitation reports be as accurate and consistent as possible. Training is provided to teach new observers how to install their instruments, properly measure precipitation and send in reports.

Simple Measuring Tools

Volunteers use high quality rain gauges. In some states, "hail pads" are used to study hail storms.

Data on the web

Volunteers post their daily observations on the CoCoRaHS Web site. Observations are immediately available on maps and reports for the public to view. By providing high quality, accurate measurements, the observers are able to supplement existing networks and provide useful results to scientists, resource managers, decision makers and other users.



CoCoRaHS observation map

Join CoCoRaHS Today!

CoCoRaHS is a practical, enjoyable and useful activity. If you have an interest in weather and would like to help your local community, as well as scientists and others interested in precipitation, then CoCoRaHS is for you. It only takes a few minutes a day and gives you the chance to participate in real hands-on science. You'll be amazed at what you learn as you become more aware of the variable weather that impacts you, your neighbors, your state and our entire country.

FOR MORE INFORMATION CONTACT: cocorahs.org

From Your Spotter Coordinator, Joe Sirard

Hello Spotters! Since we are in the middle of the Eastern Pacific Hurricane Season, it seemed appropriate to bring you a special tropical cyclone edition of *Weather or Not?*. There are two articles which focuses on tropical cyclones and their historical impacts on southern California. Although a direct hit from a tropical storm or hurricane is very rare for this region of the country, it is still possible.

One story describes this possibility and potential affects on our weather if a tropical cyclone hits. A second article brings you a comprehensive list of tropical cyclones which had directly or indirectly affected southern California during the 20th Century.

The area experienced plenty of severe thunderstorms and flash flooding this summer. Many spotter reports came in during these events. Thanks to you we continue to provide the best possible warning service to Southwestern California!

I hope you enjoy this edition of *Weather or Not?*. If you have any comments or questions please send along an email.

Tropical Cyclones That Affected Southern California in the 20th Century

Data compiled by former NWS Los Angeles/Oxnard forecasters Greg Martin and Bob Burke

The following list contains information an all the tropical cyclones that directly or indirectly affected southern California during the 20th Century.

- **July 1902:** The remnants of a tropical cyclone, which made landfall in southern Baja California, produced rainfall of up to 2 inches in the deserts and southern mountains of southern California on the 20th and 21st. This occurred during the strong El Niño of 1901-02.

- **August 1906:** This tropical cyclone tracked north northwestward across the Gulf of California into the southwestern states generating rainfall of up to 5 inches in the deserts and southern mountains of southern California on the 18th and 19th. This occurred during the El Niño of 1905-06.

- **September 1910:** The remnants of a tropical cyclone tracked northward into Santa Barbara county producing rainfall of 2 inches in the mountains of Santa Barbara County on the 15th.

- **August 1915**: The remnants of a tropical cyclone moved northward across northern Baja California into the deserts of southern California with rainfall of 1 inch at Riverside on the 26th. This occurred during the strong El Niño of 1914-15.

- **September 1918**: The remnants of a tropical cyclone tracking to the north northwest off the coast of Baja California and southern California generated rainfall of 7 inches in the mountains of northern California, but only light amounts for coastal areas of southern California on the 11th and 12th. This occurred during the El Niño of 1918-19.

- **August 1921:** The remnants of a tropical cyclone tracked northward into western Arizona from central Baja California generating rainfall of up to 2 inches in the deserts and southern mountains of southern California on the 20th and 21st. This occurred during the La Niña of 1920-21.

- **September 1921:** The remnants of a tropical cyclone tracked northeastward across northern Baja California into southwest Arizona producing rainfall of up to 4 inches in the deserts of southern California on the 30th. This occurred during the La Niña of 1920-21.

- **September 1929:** A tropical cyclone moved north northwestward just off the west coast of Baja California, dissipating off the coast of northern Baja California. Rainfall of up to 4 inches occurred in the southern mountains and deserts of southern California on the 18th.

- **September 1932:** A tropical cyclone tracked north northwestward across the Gulf of California. The remnants generated rainfall of up to 7 inches in the mountains and deserts of southern California over a 4 day period ending on October 1st. Rainfall of 4.38 inches at Tehachapi in 7 hours on the 30th caused flash floods on Auga Caliente and Tehachapi Creeks resulting in 15 deaths. This occurred during the El Niño year of 1932-33.

- **August 1935:** A tropical cyclone tracked northward across southern and central Baja California. The remnants spread into Arizona generating rainfall of up to 2 inches in the southern valleys, mountains, and deserts of southern California on the 25th.

- **August 1936:** A tropical cyclone tracked north northwestward across the Gulf of California with the remnants tracking northward into western Arizona. Locally heavy rainfall occurred in the mountains surrounding Los Angeles on the 9th.

- **Four storms affected southern California during the one month of September 1939, including the only storm on record as actually hitting California as a tropical storm. All these storms occurred during the El Niño of 1938-39.**

- **The remnants** of a hurricane tracked northeastward across northern Baja California into southwest Arizona generating rainfall of up to 7 inches in the southern mountains and southern and eastern deserts of southern California on the 4th through 7th with the heaviest rain on the 5th and 6th. Blythe received more rain than would normally fall in one year and Imperial received more rain than would normally fall in two years.

- **The remnants** of a second tropical cyclone tracked northeastward across northern Baja California into southwest Arizona. Moisture from this tropical cyclone interacted with an upper trough to the north generating rainfall of up to 4 inches in the deserts and central and southern mountains of southern California on the 11th and 12th.

- **A tropical cyclone** moving northwestward, just off the west coast of Mexico, moved into southern Baja California and dissipated. The moisture from this tropical cyclone generated rainfall of up to 3 inches in the deserts and central and southern mountains of southern California on the 19th through 21st.

- **Near the end of the month** a tropical cyclone moving to the northeast moved onshore at Long Beach at tropical storm strength with sustained winds of 50 mph. This is the only known eastern Pacific tropical cyclone to move onshore into southern California at tropical storm strength. Rainfall of 5 inches in the Los Angeles basin and 6 to 12 inches in the surrounding mountains occurred on the 25th. The heaviest rain in the deserts occurred the day before with 6.45 inches of rain at Indio in a 6-hour period on the 24th.

- **September 1941:** Moisture from a north northwestward moving hurricane that slammed into southern Baja California generated rainfall of up to 1 inch in the southern mountains and deserts of southern California. This occurred during the strong El Niño of 1941-42.

- **September 1945:** A tropical cyclone moving north northwestward just off the west coast of Baja California...dissipated off the coast of northern Baja California. Showers produced rainfall up to two inches in the central and southern mountains of southern California on the 9th and 10th.

- **September 1946**: A tropical storm moved northward into northern Baja California and dissipated with rainfall of up to 4 inches in the southern mountains of southern California on the 30th and exceeding 4 inches in the central mountains of southern California on October 1st. This occurred during the El Niño of 1946-47.

- **August 1951:** A hurricane moving north northwestward just off the west coast of Baja California moved northeastward into northern Baja California and dissipated. Moisture from this tropical cyclone resulted in rainfall of 2 to 5 inches in the southern mountains and deserts of southern California on the 27th through 29th. Many roads were washed out in the imperial valley, but otherwise no major damage occurred in southern California. This occurred during the El Niño of 1951-52.

- **September 1952:** A west-northwestward moving tropical storm southwest of Baja California dissipated. Moisture from this storm resulted in rainfall of up to 2 inches in the deserts and central and southern mountains of southern California on the 19th through 21st with most falling on the 19th. This occurred during the El Niño of 1951-52.

- **July 1954:** A northward moving hurricane made landfall in central Baja California with the remnants moving into Arizona. Rainfall of up to 2 inches occurred in the deserts and mountains of southern California on the 17th through 19th. This occurred during the El Niño of 1953-54.

- **July 1958:** Moisture from a west northwestward moving tropical storm which dissipated west of central Baja California generated up to 2 inches of rainfall in the deserts and mountains of southern California on the 28th and 29th. This occurred during the El Niño of 1957-58.

- **September 1959:** A north northwestward moving hurricane made landfall in southern Baja California with the remnants tracking across Baja California into southern California. Spotty rainfall amounts of up to one-half inch were recorded in the deserts and mountains of southern California on the 11th.

- **September 1960:** North northwestward moving Hurricane Estelle dissipated west of the central Baja California coast. The heaviest rains in southern California were over the southern mountains with 3.40 inches at Julian on the 9th and 10th.

(Continued on Page 5)

Tropical Cyclones That Affected Southern California in the 20th Century

(Continued from page 4)

- **September 1963**: Northeastward moving Tropical Storm Katherine made landfall in northern Baja California with rainfall of up to 7 inches in the central and southern mountains of southern California on the 17th through 19th. This occurred during the El Niño of 1963-64.

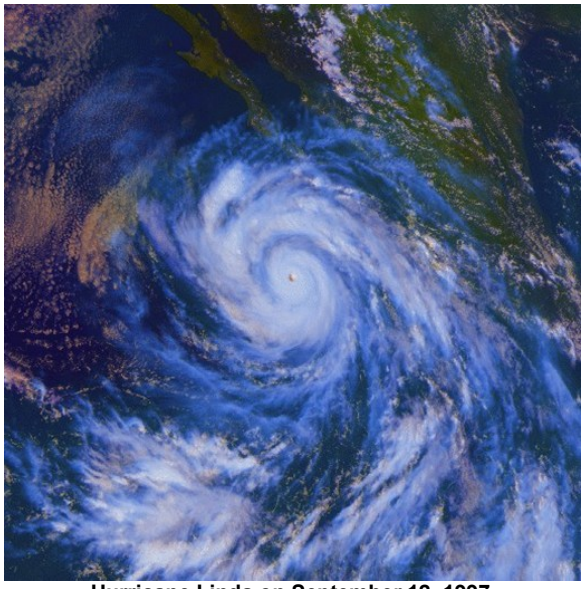
- **September 1965**: North northwestward moving Hurricane Emily dissipated just off the west coast of central Baja California with spotty rainfall amounts up to 1 inch in the mountains of southern California on the 4th and 5th. This occurred during the El Niño of 1965-66.

- **September 1967:** Hurricane Katrina crossed the southern tip of Baja California, then traversed almost the entire length of the Gulf of California before making landfall again and rapidly weakening. Rainfall of 2 inches occurred in the southern mountains and deserts of southern California on the 1st through 3rd.

- **September 1971:** Caribbean sea Hurricane Irene crossed Nicaragua and reformed in the eastern Pacific as Hurricane Olivia. Olivia recurved to the northeast and made landfall in central Baja California with rainfall of up to one inch in the southeast deserts of southern California on the 30th and October 1st. This occurred during the La Niña of 1970-71.

- **September 1972:** Hurricane Hyacinth moved as far west as 125 west before recurving to the northeast. The remnants made landfall between Los Angeles and San Diego on the 3rd with winds of 25 mph and rainfall of up to one inch in the central and southern mountains of southern California. This tropical cyclone holds the distinction of traveling the farthest west before recurving and making landfall in southern California. This occurred during the El Niño of 1972-73.

- **October 1972:** Hurricane Joanne recurved making landfall in northern Baja California, maintaining tropical storm strength into Arizona and generating rainfall up to 2 inches in the southeast deserts of southern California on the 6th. This occurred during the strong El Niño of 1972-73.



Hurricane Linda on September 12, 1997

- **September 1976:** North-northwestward moving Hurricane Kathleen made landfall in northern Baja California with the remnants moving into southern California. Hurricane Kathleen brought the southwest the highest sustained winds ever associated with an eastern Pacific tropical cyclone with sustained winds of 57 mph at Yuma on the 10th. Six to 12 inches of rainfall was observed in the central and southern mountains of southern California on the 10th and 11th. Most of Ocotillo, California was destroyed by flooding and three persons drowned. This occurred during the El Niño of 1976-77.

- **August 1977:** Hurricane Doreen tracked north northwestward along the west coast of Baja California, dissipating over the southern California coastal waters. Most areas of southern California from Los Angeles south received at least 2 inches of rainfall with up to 8 inches in the mountains. Flooding was widespread with extensive crop damage. This occurred during the El Niño of 1977-78.

- **October 1977:** Hurricane Heather recurved with the remnants tracking across northern Baja California into Arizona. There was rainfall up to 2 inches in the southern mountains and deserts of southern California on the 6th and 7th. This occurred during the El Niño of 1977-78.

- **September 1978:** Hurricane Norman recurved with the remnants tracking into southern California from the south southwest. Rainfall was most intense on the 5th and 6th with amounts exceeding 3 inches in the mountains of southern California. This occurred during the El Niño of 1977-78.

- **June 1980:** The northward moving remnants of Hurricane Celia produced scattered rainfall amounts up to one half inch in Santa Barbara County on the 29th and 30th.

- **September 1982:** The remnants of Hurricane Norman tracked northeastward across northern Baja California into Arizona with scattered rainfall amounts up to 1 inch in the southern mountains and deserts of southern California on the 17th and 18th. This occurred during the strong El Niño of 1982-83.

- **September 1982:** The remnants of Hurricane Olivia recurved northeastward across southern California with rainfall up to 4 inches in the mountains of southern California on the 24th through 26th. This occurred during the strong El Niño of 1982-83.

- **September 1983:** Northward moving Hurricane Manuel dissipated off the west coast of northern Baja California with up to 3 inches of rainfall in the southern mountains and deserts of southern California on the 20th and 21st. This occurred during the strong El Niño of 1982-83.

- **October 1983**: The remnants of northward moving Hurricane Priscella tracked across southern California with only scattered light rainfall on the 7th. This occurred during the strong El Niño of 1982-83.

- **September 1984:** North northwestward moving Hurricane Marie dissipated off the west coast of northern Baja California with only scattered light rainfall for coastal southern California on the 10th and 1lth.

- **August 1997:** The remnants of Hurricane Ignacio tracked northward moving inland in central California with gale force winds over portions of the southern California coastal waters. This occurred during the strong El Niño that began in 1997

- **September 1997:** Hurricane Linda became the strongest storm recorded in the eastern Pacific with winds estimated at 180 mph and for a time threatened to come ashore in California as a tropical storm. But the storm turned away, affecting the state with high surf and added moisture for showers and thunderstorms. This occurred during the strong El Nino that began in 1997.

Did you know?

The lowest non-tornadic sea-level barometric pressure ever recorded was 870 millibars (25.69 inches). This measurement was made from the eye of Typhoon Tip in the western Pacific on October 12, 1979 using special instruments from reconnaissance aircraft.

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This Spotter Newsletter is issued as part of the SKYWARN Storm Spotter Program at the Los Angeles/Oxnard National Weather Service Office.

If you are interested in becoming a volunteer Storm Spotter, please access the online training materials at http://www.wrh.noaa.gov/lox/spotter/course/

After reviewing the training slides you will need to take a short quiz. Following the training you will be an official SKYWARN Storm Spotter!

New spotters will receive a packet of information including our Storm Spotter Pocket Guide and a Spotter ID Badge.

Thanks for your interest in the Spotter Program!

What to Report?

Remember to please keep calls short with the information given below, as well as specific times and locations of reports, and a reference to the nearest city/town (if possible). There are many spotters who call at the same time. This helps all calls get through in a timely manner.

Flooding/Debris Flows:
- Rainfall Intensity: How much is falling over a specific period?
- Flooding or Debris Flows that are threatening life/property, or are disrupting traffic.
- Describe the flooding:
  - water depth
  - time it began and ended

Winter Weather:
- Amount, rate and time of new snow accumulations.
- Elevation of snow level
- Icing of roads or road closures
- Very low temperatures:
  - Coast: 35 degrees or lower
  - Valleys: 30 degrees or lower
  - Deserts: 20 degrees or lower
- Significant wind chill

Fog:
- Report visibilities less than or equal to 1/4 mile

Wind:
- Report winds of 30 mph or more
- Speed of winds (sustained or gusts)

Extreme Heat:
- Report for these temperature thresholds:
  - Coast: 95 degrees or higher
  - Valleys: 105 degrees or higher
  - Deserts: 115 degrees or higher

Thunderstorms:
- Estimated location, duration, speed and direction of movement
- Any hail (size, accumulation, etc)
  - 1/4" = pea size
  - 1/2" = marble size
  - 3/4" = penny size
  - 1" = quarter size
  - 1 3/4" = golf ball size
- Wind speeds and gusts
- Rainfall rate and amount
- If lightning strikes any object

Surf:
- Report when surf is 6 feet or greater
- Any flooding or damage caused by high tides and/or high surf

Tornadoes:
- Funnel clouds, waterspouts or any rotating clouds
- Estimated location, duration, speed and direction or movement

Damage or Injuries:
- Please report any confirmed weather-related damage, injuries, or deaths.